Geophysical Research Abstracts
Vol. 19, EGU2017-3520, 2017
EGU General Assembly 2017

Temperature trends in the northern winter middle atmosphere in relation to the QBO

Axel Gabriel

Leibniz-Institute of Atmospheric Physics at the University Rostock e.V., Kuehlungsborn, Germany (gabriel@iap-kborn.de)

Long-term temperature trends in the stratosphere and mesosphere due to anthropogenic greenhouse gas emissions are examined in relation to the effect of the equatorial Quasibiennal Oscillation (QBO) on the northern mid-winter circulation. The examinations are based on the CMIP5 simulations 1979-2100 of the Earth-System-Model MPI-ESM that generates the QBO internally. A remarkable result is that the trends in temperature, zonal wind and residual circulation are much stronger during the westerly (QBO-W) than the easterly (QBO-E) phase of the QBO (factor 2-4), because of a change in the response of the northern circulation to the QBO. Similar to the change from QBO-W to QBO-E signature (Holton-Tan effect), which is verified against ERA-Interim reanalysis and Aura-MLS satellite data, the trends during QBO-W include an increase in amplitude and eastward shift in phase of the stationary wave one at the cost of the wave two patterns. An in-depth-analysis, including examinations of the three-dimensional residual circulation, demonstrates that this trend behaviour is primarily produced by (1) increasing transient eddies over North America, which diminish planetary-scale Rossby waves excited by the Rocky Mountains and their contribution to the wave two, and (2) increasing meridional transport of planetary vorticity due to the increase in wave one, which leads to the eastward shift of the wave one and embedded westerlies over the Rocky Mountains, further diminishing the orographically-induced Rossby waves. Subsequent changes in the time-mean effects of sudden stratospheric warming (SSW) events, indicating a weak decrease in the total number of SSWs per decade but a relative increase of vortex displacements at the cost of vortex splits, and possible impacts on surface climate conditions via stratosphere-troposphere coupling are discussed.